TRACK 2

JAVA CONCURRENCY PRIMITIVES

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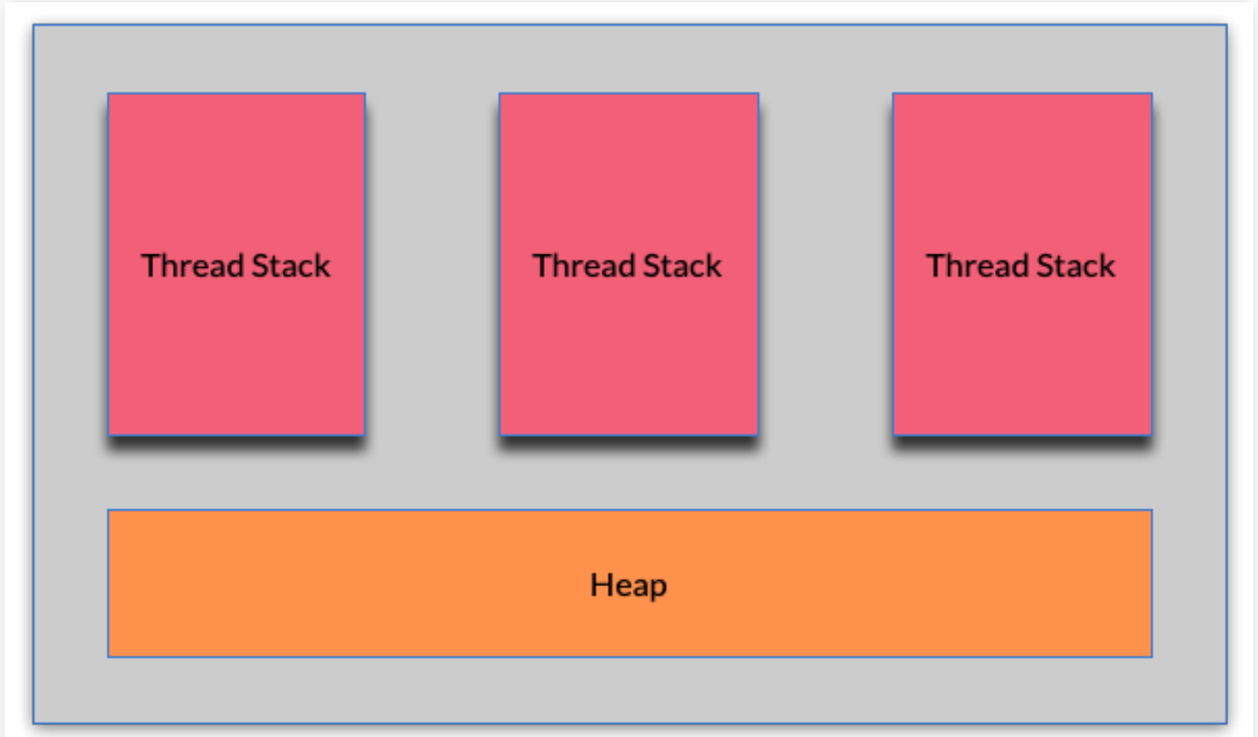
JAVA MEMORY MODEL

ABOUT THE MEMORY MODEL

- Still the same Memory Model since Java 5
- Comes in two components
  - Stack (or Thread Stack)
  - Heap

MEMORY DIAGRAM



THREAD STACK

- Every thread in the JVM has its own thread stack.
- Thread stacks contains information about what methods the thread has called to reach the current point of execution.
- Referred as the "call stack", which if called repeatedly results in `StackOverflowError`
- As the thread executes its code, the call stack changes.

THREAD STACK INTERNALS

- Thread stack also contains all local variables for each method being executed internal to the stack
- A Thread can only access the local variables in it’s stack
- Local variables in a Thread are not visible to another Thread
- Each thread will only have access to it’s copy, but copies can be sent to other threads

JVM HEAP

- Contains the objects that are used by the Threads in the Stack
- Objects also include wrappers `Integer`, `Long`, etc.

JVM PRIMITIVES AND OBJECTS

- If the variable is a primitive type, then it is stored in the Thread stack
- Object References
  - If the variable is a object reference, the variable is stored in the Thread Stack
  - The object that the object refers to is stored in the Heap and undergoes heap lifecycle
  - The object's member variable are also stored on the heap
  - `static` class variables are stored on the heap with the class definition

HEAP OBJECTS

- Objects on the Heap can be accessed by any Thread Stack
- Two references on the Thread Stack can access:
  - Object reference
  - Object's class reference
  - Object's member variables
  - Object's class `static` members

DEMO: STACK OR HEAP?

Go to *targeted_advanced_java/src/main/java* and open the *JavaMemoryModel.java* file in the `com.xyzcorp.memorymodel` package

MEMORY MODEL AND PHYSICAL MEMORY

- Hardware memory architecture does not distinguish between thread stacks and heap
- Both the thread stack and the heap are located in main memory
- Parts of the thread stacks and heap may sometimes be present in CPU caches and in internal CPU registers

VIRTUAL STACKS AND HEAP AND PHYSICAL RAM

ISSUES WITH THE JVM

There are two issues in regards to physical memory when running the JVM

- Visibility of thread updates (writes) to shared variables.
- Race conditions when reading, checking and writing shared variables.

VISIBILITY OF SHARED OBJECTS

- If two or more threads share an object, without proper mitigation, updates to the shared object made by one thread may not be visible to others
- Proper mitigation techniques:
  - `volatile`
  - `synchronized`

DEMO: VISIBILITY OF SHARED OBJECT

Go to *targeted_advanced_java/src/main/java* and open the *VisibilityOfSharedObjects.java* file in the `com.xyzcorp.memorymodel` package

RACE CONDITIONS

- If two or more threads share an object
- More than one thread updates variables in that shared object race conditions may occur.
- Analogy:
  - You are planning to go to a movie at 5 pm.
  - You inquire about the availability of the tickets at 4 pm.
  - The representative says that they are available.
  - You relax and reach the ticket window 5 minutes before the show.
  - I'm sure you can guess what happens: it's a full house.

Source: https://stackoverflow.com/questions/34510/what-is-a-race-condition

volatile